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APPLICATION NO.	FILING DATE	FIRST-NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/590,464	06/09/2000	Randhir P. S. Thakur	AGX-39	1778

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EXAMINER

MARKHAM, WESLEY D

ART UNIT	PAPER NUMBER
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1762

9

DATE MAILED: 04/02/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/590,464	Applicant(s) THAKUR, RANDHIR P. S.	
	Examiner Wesley D Markham	Art Unit 1762	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 15 January 2002.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 20-25,29,30,50 and 51 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 20-25,29,30,50 and 51 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s). _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449) Paper No(s) <u>5</u> | 6) <input type="checkbox"/> Other: |

DETAILED ACTION

Acknowledgement is made of applicant's amendment A, filed as paper #7 on January 15, 2002, in which the title of the instant application was changed, a new abstract of the disclosure was provided, Claims 1 – 19, 26 – 28, and 31 – 49 were canceled, Claim 20 was amended, and Claims 50 – 51 were added. Claims 20 – 25, 29, 30, 50, and 51 are currently pending in U.S. Application Serial No. 09/590,464, and an Office Action on the merits follows.

Information Disclosure Statement

1. The IDS, filed by the applicant on August 17, 2001 as paper #5 (before the mailing date of the first Office Action), is acknowledged and has been considered.

Oath/Declaration

2. The substitute Declaration filed by the applicant on March 4, 2002 as paper #8 is acceptable.

Drawings

3. This application has been filed with informal drawings which are acceptable for examination purposes only. Formal drawings will be required when the application is allowed.

Specification

4. The objections to the specification (specifically to the title and abstract of the instant application), set forth in paragraphs 4 – 6 of the previous Office Action, are withdrawn in light of applicant's amendment A.

Claim Rejections - 35 USC § 112

5. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

6. The rejection of Claims 11 – 12 and 37 – 39 under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention, set forth in paragraphs 8 – 9 of the previous Office Action, is withdrawn in light of applicant's amendment A, in which Claims 11 – 12 and 37 – 39 were canceled.
7. In light of applicant's amendment A and corresponding remarks, the rejections under 35 U.S.C. 102 (b) and (e), set forth in paragraphs 11 – 20 of the previous Office Action, and the rejections under 35 U.S.C. 103(a), set forth in paragraphs 22 – 54 of the previous Office Action, are withdrawn.

Claim Rejections - 35 USC § 102

8. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

9. Claim 50 is rejected under 35 U.S.C. 102(b) as being anticipated by Nishizawa et al. (USPN 5,443,033).
10. Regarding independent Claim 50, Nishizawa et al. teach a method of forming layers in electronic devices, the method comprising providing a reaction chamber (Figure 1, reference number "1", and Col.4, lines 21 – 22), placing a semiconductor wafer in the reaction chamber (Figure 1, reference number "12", and Col.4, lines 54 – 56), heating the semiconductor wafer with a thermal heating device placed adjacent to the wafer (Figure 1, reference number "10", and Col.4, lines 36 – 39 and 60 – 61), pulsing a precursor fluid into the reaction chamber to form a solid layer on the semiconductor wafer (Col.4, lines 52 – 69 and Col.5, lines 1 – 19), thereafter exposing the solid layer to light energy in the reaction chamber, wherein the precursor fluid is substantially exhausted and removed from the reaction chamber and the solid layer is exposed to light energy in between each pulse of the precursor fluid (Col.4, lines 65 – 66, Col.5, lines 3 – 8, Col.6, lines 22 – 28). Specifically, Nishizawa et al. teach that the substrate with the growing epitaxial layer is irradiated with UV irradiation continuously during the process of growth (Col.6,

lines 22 – 28). This time period (i.e., the period of growth) includes the time period in which the chamber is exhausted between the pulses of reactant gases (Col.4, lines 52 – 68, and Col.5, lines 1 – 7). Further, Nishizawa et al. teach that the solid layer can comprise aluminum (Col.6, lines 29 – 42).

Claim Rejections - 35 USC § 103

11. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

12. Claims 20 – 21, 23 – 25, and 29 – 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Utsumi et al. (USPN 5,495,822) in view of Dautartas et al. (USPN 6,124,158).

13. Utsumi et al. teach all the limitations of Claims 20 – 21, 23 – 25, and 29 – 30 as set forth in paragraphs 48 – 50 of the previous Office Action, except for a method wherein, between each pulse of precursor fluid, the reaction chamber is purged by flowing an inert gas through the reaction chamber in order to substantially remove any precursor fluid not converted into a solid. However, Utsumi et al. do teach that while the light energy is supplied, the flow of precursor gas is stopped (Col.5, lines 39 – 45). This is done to prevent the radiation from exciting the precursor gas to produce a vapor phase decomposed species that would deposit on the substrate

(Col.5, lines 46 – 49). Dautartas et al. teach a similar atomic layer epitaxial process for depositing a layer in a semiconductor device (Abstract). Further, Dautartas et al. teach that it was known in the art at the time of the applicant's invention to purge a reaction chamber with an inert gas between pulses of precursor gases to remove residual reactive material from the chamber in order to prevent reactions from taking place except on the surface of the substrate (Col.3, lines 23 – 67, and Col.4, line 1). Therefore, it would have been obvious to one of ordinary skill in the art to purge the reaction chamber of Utsumi et al. with an inert gas between the precursor gas pulses in order to substantially remove any remaining vaporous precursor material from the chamber with the reasonable expectation of (1) success, as Dautartas et al. teach that such a process is possible and known in the art, and (2) obtaining the benefits of the inert gas purging step, such as removing residual reactive material from the chamber in order to prevent reactions from taking place except on the surface of the substrate (i.e., preventing unwanted vapor phase decomposed species, as desired by Utsumi et al.).

14. Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Utsumi et al. (USPN 5,495,822) in view of Dautartas et al. (USPN 6,124,158), and in further view of Murota et al. (USPN 5,705,224).
15. The combination of Utsumi et al. and Dautartas et al. teaches all the limitations of Claim 22 as set forth in paragraph 13 above, except for a method wherein the thermal heating device comprises an electrical resistance heater. However, using

an electrical resistance heater to heat the substrate as claimed by the applicant would have been obvious to one of ordinary skill in the art in light of Murota et al. for the reasons set forth in paragraph 52 of the previous Office Action.

16. Claims 20 – 25 and 29 – 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nishizawa et al. (USPN 5,443,033) in view of Dautartas et al. (USPN 6,124,158).
17. Nishizawa et al. teach all the limitations of Claim 20 as set forth in paragraph 10 above (which concerns Claim 50), except for a method wherein, between each pulse of precursor fluid, the reaction chamber is purged by flowing an inert gas through the reaction chamber in order to substantially remove any precursor fluid not converted into a solid. However, Nishizawa et al. do teach that between the pulses of precursor fluid, the chamber is evacuated (Col.4, lines 60 – 68). Dautartas et al. teach a similar atomic layer epitaxial process for depositing a layer in a semiconductor device (Abstract). Further, Dautartas et al. teach that it was known in the art at the time of the applicant's invention to purge a reaction chamber with an inert gas between pulses of precursor gases to remove residual reactive material from the chamber in order to prevent reactions from taking place except on the surface of the substrate (Col.3, lines 23 – 67, and Col.4, line 1). Therefore, it would have been obvious to one of ordinary skill in the art to purge the reaction chamber of Nishizawa et al. with an inert gas between the precursor gas pulses (i.e., instead of simply evacuating the chamber between pulses as taught by Nishizawa et al.) in

order to substantially remove any remaining vaporous precursor material from the chamber with the reasonable expectation of (1) success, as Dautartas et al. teach that such a process is possible and known in the art, and (2) obtaining the benefits of the inert gas purging step, such as removing residual reactive material from the chamber in order to prevent reactions from taking place except on the surface of the substrate. Dautartas et al. teach that this technique eliminates gas phase reactions and gas phase powder formation, both of which detract from the quality of the film (Col.3, lines 66 – 67, and Col.4, line 1).

18. The combination of Nishizawa et al. and Dautartas et al. also teaches all the limitations of Claims 21 – 25 and 29 – 30 as set forth above in paragraph 17 and below, including a method wherein / further comprising:

- Claim 21 – The precursor fluid comprises a gas (Col.4, line 61 of Nishizawa et al.).
- Claim 22 – The thermal heating device comprises an electrical resistance heater (Col.4, lines 33 – 39 of Nishizawa et al.).
- Claim 23 – The reaction chamber has walls maintained at a temperature lower than the substrate during formation of the layer. While not explicitly taught by Nishizawa et al., Nishizawa et al. do teach that the substrate is directly heated to a predetermined temperature (see Figure 1, reference number “10”, and Col.4, lines 60 – 61). Therefore, the walls of the reaction chamber of Nishizawa et al. (which are not directly heated) would have

inherently had a lower temperature than the substrate, which is directly heated.

- Claims 24 – 25 and 30 – The reaction chamber is maintained at a pressure of less than about 760 torr, preferably less than about 3 torr, preferably between about 10^{-2} torr and 10^{-7} torr, when pulsing the precursor fluid into the reaction chamber. Specifically, Nishizawa et al. teach a pressure of 0.1 Pascal, which correlates to about 7.5×10^{-4} torr (i.e., a pressure within the applicant's claimed range) (Col.4, lines 64 – 65).
- Claim 29 – The semiconductor wafer is maintained at a temperature of at least 100°C during formation of the solid layer. Specifically, Nishizawa et al. teach a substrate temperature of between 300 and 800°C (Col.4, lines 60 – 61).

19. Claim 51 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nishizawa et al. (USPN 5,443,033) in view of Goodman et al. (USPN 5,311,055).

20. Nishizawa et al. teach all the limitations of Claim 51 as set forth in paragraph 10 above (which concerns Claim 50), except for a method wherein the solid layer comprises a material selected from the group consisting of zirconium oxide, aluminum oxide, a nitride, barium strontium titanate, and a silicate. However, Nishizawa et al. are broadly concerned with depositing semiconductor crystals in general utilizing their epitaxial process, and the specific semiconductor material that is deposited does not appear to be critical to the process (Col.6, lines 29 – 42).

Some exemplary materials that are deposited by Nishizawa et al. include GaAs and GaP. Goodman et al. teach the functional equivalence of materials such as GaAs and GaP (as taught by Nishizawa et al.) and GaN (i.e., a nitride) in ALE deposition processes for the production of semiconductor devices (Col.9, lines 31 – 54).

Therefore, it would have been obvious to one of ordinary skill in the art to deposit GaN in the process of Nishizawa et al. with the reasonable expectation of success and of obtaining similar results (i.e., an epitaxially grown semiconductor material, as desired by Nishizawa et al.).

Response to Arguments

21. Applicant's arguments filed on 1/15/2002 have been fully considered but they are not persuasive. Specifically, the applicant's arguments have been rendered moot by the new grounds of rejection presented above.

Conclusion

22. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Wesley D Markham whose telephone number is (703) 308-7557. The examiner can normally be reached on Monday - Friday, 8:00 AM to 4:30 PM.
23. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Shrive Beck can be reached on (703) 308-2333. The fax phone numbers for the organization where this application or proceeding is assigned are

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(703) 872-9310 for regular communications and (703) 872-9311 for After Final communications.

24. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.



WDM
March 27, 2002

Wesley D Markham
Examiner
Art Unit 1762



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